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J.K+C

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SUPPORT AND SALES

An electrostatic mineral separation device

Field of the invention

[0001] The present invention relates to a mineral separation device which utilises electrostatic techniques to separate a mixture of particulates, so that desirable particulates can be subsequently extracted and used.

Background of the invention

[0002] Conventional electrostatic high tension (HT) separator systems utilise a series of three vertically arranged rollers with corresponding electrodes. As the particulates fall they cascade over the rollers in a thin curtain. As the particulates pass over the roller they are exposed to an ionising field created by high voltage electrodes and the particulates become charged. Any conductive particulates will, whilst in contact with a roller, impart its charge to the metal roller and will then follow a natural trajectory. After it is thrown from the roller it may experience a lifting force due to the ionised filed.

[0003] The non-conductive particles cannot discharge as quickly and will be attracted to the surface of the roller due to the disparity between the charged particles and the roller's surface. The non conductive particles will then follow the surface of the roller, as it rotates, to a point where their charge dissipates and they fall off or are removed with a brush.

[0004] The applicant does not concede that the prior art discussed in the specification forms part of the common general knowledge in the art at the priority date of this application.

Summary of the invention

[0005] The present invention provides an electrostatic separation device to separate components of a mixture of particulates, said device including a means to electrostatically charge said particulates and a first roller and a second roller which are conductive, said first and second roller being arranged one above the other, said device including third and fourth rollers which are also conductive, said first and second rollers each producing a non-conductive output and conductive output, which proceeds respectively to said third roller and said fourth roller, with said first and second rollers producing a mids output, said mids output from said first roller proceeding onto said second roller.

[0006] The first and second rollers do not re-treat either of the conductive or non-conductive outputs.

[0007] The non-conductive stream from the fourth roller, and the conductive stream from the third roller can join into a single stream with the mids stream from the second roller.

[0008] The fourth roller can be considered to be a "conductor cleaner" and the third roller can be considered a "non-conductor" cleaner.

[0009] The third roller can have a non-conductive, a mids, and a conductive output, or just a conductive and a non-conductive output.

[0010] The fourth roller can have a conductive, a mids, and a non-conductive output, or just a conductive and a non-conductive output.

[0011] The device can be utilised in a separation plant as a primary (roughing) stage and or a re-treatment stage, which may be a third or fourth stage in a plant.

[0012] The present invention also provides a separation plant including at least one of said previously described devices, whereby the mids output of said device is fed to an alternative high tension separation device of a different design.

[0013] The conductive output of the high tension separation device can be fed to an electrostatic plate machine.

[0014] The present invention further provides a method of separating particulates from a mixture of particulates, said method including the steps of electrostatically charging said particulates and passing same over a first and second rollers which are conductive, whereby the non-conductive output and conductive output of said first roller bypasses said second roller, said second roller processing only the mids output from said first roller.

[0015] The method also including the step passing the non-conductive output of said first and second rollers to a third roller, while the conductive output of said first and second roller is passed to a fourth roller.

[0016] The non-conductive stream from the fourth roller, and the conductive stream from the third roller can join into a single stream with the mids stream from the second roller.

[0017] The fourth roller can be considered to be a "conductor cleaner" and the third roller can be considered a "non-conductor" cleaner.

[0018] The third roller can have three outputs being non-conductive, a mids, and a conductive output. Alternatively, the third roller can have only two outputs being a conductive and a non-conductive output.

[0019] The fourth roller can have three outputs being a conductive, a mids, and a non-conductive output. Alternatively, the fourth roller can have only two outputs being a conductive and a non-conductive output.

[0020] The first and second rollers do not re-treat either of the conductive or non-conductive outputs.

[0021] The present invention also provides a separation plant having a series of said devices as described above.

Brief description of the drawings

[0022] An embodiment or embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

[0023] Figure 1 is a schematic view of a conventional electrostatic separation device;

[0024] Figure 2 is a schematic view of an improved electrostatic separation device where the third and fourth rollers each have a two stream output;

[0025] Figure 3 is a diagram showing, in cross section of a machine embodying the separation device of figure 2, except that the third and fourth rollers each have a three stream output;

[0026] Figure 4 is a flow chart of an improved circuit which utilises the device of figure 3;

[0027] Figure 5 and Table 1 illustrate a representative example of the machine of figure 2;

[0028] Figure 6 and Table 2 illustrate a representative example of the machine of figure 3;

[0029] Figure 7 and Table 3 illustrate a representative example of a machine with a third roller with two outputs, and the fourth roller having three outputs; and

[0030] Figure 8 illustrates a schematic of an improved flow process through a machine where the third roller is passing a portion of its output to a fourth roller.

Detailed description of the embodiment or embodiments

[0031] Illustrated in figure 1 is a conventional or prior art machine 10, which utilises on three rollers 12, 14 and 16. The feed 18 is electrostatically charged by electrodes (not shown) after it contacts the roller 12, which takes the charge immediately away from those particles

which are conductive. The conductive output is then gathered, as schematically illustrated on the right hand side 20 of figure 1.

[0032] Meanwhile, the non conductive particulates, due to their non-conductive nature remain in contact with the roller 12 where their charge slowly dissipates thus allowing them to fall or the non-conductive particulates are brushed or scraped off the roller 12 and are electrostatically charged again during contact with the roller 14. The process on roller 14 continues in the same manner as for roller 12. The same occurs in respect of roller 16, except that any non-conductive particulates are separated as are any middlings or mids, with the conductive particulates being moved to the same location as the conductive particulates from rollers 12 and 14. Each roller has its own electrodes for charging.

[0033] By contrast, the machine 100 embodying the invention is illustrated in figure 2. The machine 100 has four rollers 112, 114, 116 and 118.

[0034] The first and second rollers 112 and 114 have the particulates output, which are conductive, separated from the particulate stream, and sends this conductive output to the fourth roller 118, where it is cleaned and the conductive output sent to its collection area while any mids are sent to the mids collection area.

[0035] Likewise, the first and second rollers 112 and 114 have the non-conductive output of particulates separated from the particulate stream, and sends the non-conductive output to the third roller 116, where it is cleaned and the non-conductive output sent to its collection area while any mids sent to the mids collection area.

[0036] The mids from the first roller 112 are then passed to the second roller 114, whereupon any remaining mids are sent to the mids collection area to join the outputs from the third roller 116 and fourth roller 118.

[0037] Illustrated in figure 3 is a more detailed representation of the machine 100 of figure 2, except that the third and fourth rollers 116 and 118 respectively each have three possible outputs.

[0038] In this version, the electrodes 120, 121, 122 and 123 and respective separation rollers 112, 114 116 and 118 are of the type described in PCT/AU01/00917 published as WO02/09882, the text and illustrations of which are incorporated herein by reference.

[0039] In figure 3, the electrode 120 provides an ionising charge to the particulates which are fed out of the feed hopper 130 onto the roller 112. The ionising charge on conductive

particles is immediately transferred to the roller 112, which is made of a conductive material, such as a chrome plated mild steel, due to the conductive nature of the particulates. Accordingly the conductive particulates are ejected or propelled tangentially in a stream 140 from the roller 112, which is rotating at a rate of between 150 RPM and 250 RPM.

[0040] The mids, due to their slower dissipation of charge to the roller 112, will remain attracted to the roller, until the centripetal force from the rotating roller 112 overcomes the force of attraction of the mids particulates to the roller 112. These factors result in the mids leaving the roller 112 tangentially thereto in a mids stream 150, which is at a point on the roller 112 that is angularly spaced from the point of departure of the conductive output stream 140.

[0041] The non-conductive particulates on the roller 112 remain on the roller 112 for the longest time of the three possible outputs. The non-conductive particulates are brushed off the roller 112 to form a non-conductive stream 160.

[0042] As can be seen from figure 3, the non-conductive stream 160 progresses under gravitational forces to the roller 116, while the conductive stream 140 proceeds directly to the roller 118. The mids stream 150 from roller 112 proceeds into the feed hopper 131 to be fed tot he roller 114. In a similar process to the roller 112, the roller 114 and electrode 121 splits the feed from the hopper 131 into three streams, conductive output 141, mids output 151 and non-conductive output 161.

[0043] The non-conductive output 161 proceeds directly to the feed hopper 132 for the roller 116, while the conductive output 141 proceeds directly to the feed hopper 133 for the roller 118. The mids stream 151 proceeds directly discharge launders.

[0044] Roller 116 and electrode 122 will produce three output streams being a conductive stream 142, a mids stream 152 and a non-conductive stream 162. The non-conductive stream 162 moves directly to a non-conductive collection hopper, but any particulates which are in the conductive stream 142 or the mids stream 152, are sent to the mids collection hopper.

[0045] The output from the roller 118 and electrode 123 will produce three output streams being a conductive stream 143, a mids stream 153 and a non-conductive stream 163. The non conductive stream 163 moves directly to a conductive collection hopper, but any particulates which are in the non-conductive stream 143 or the mids stream 153, are sent to the mids collection hopper.

[0046] Illustrated in figure 4 is schematic of a multistage processing circuit 200, where the first and second stages, being first rougher stage 202 and second rougher stage 204, a comprised of separation devices 100 as illustrated in figures 2 and 3. In the circuit 200, only the mids resulting from the first stage 202 are retreated in the second stage, as the non-conductive and conductive outputs have been cleaned respectively by rollers 116 and 118 in the machine 100 which is part of stage 202. The same happens in respect of the second stage 204, with only the mids proceeding to being cleaned by the High Tension Separator 206 to extract the remaining conductive particulates and separate them by means of the electrostatic plate machine 208.

[0047] Illustrated in figure 5 and table 1 is an illustrative hypothetical example using a mixture of minerals to be separated, that mixture being 50% Zircon and 50% Rutile. Table 1 is a tabular version of the figure 5 information. The machine set up is the same as that for the machine 100 of figure 2, where the third roller 116 and fourth roller 118 each have only two output streams, being a conductive outputs 142 and 143 respectively, to the right, and a non-conductive outputs 162 and 163 respectively, to the left. Further the rollers 112 and 114 each have three output streams respectively being: conductive outputs 140, 141; mids or middling outputs 150, 151; and non-conductive 160, 161.

[0048] The key as mentioned in the top right hand column is such that the nest of figures at each location in the separation process are as follows:

[0049] Top left location: number of tonnes per hour input to or output from a roller;
Middle left location: % of Zircon separated;
Middle right location: % of Rutile separated;
Lower left location: tonnes per hour of Zircon processed; and
Lower right location: tonnes per hour of rutile processed.

[0050] In the example of figure 5 the zircon output is the non-conductive particulate, while the rutile is the conductive particulate. It will be noted that the percentage of rutile in the conductive output 143 of fourth roller 118 is relatively high, as is the non-conductive output of the third roller 116. Whereas the mids output, being a combination of the streams 151 from second roller 114, and the conductive output 142 from third roller 116 and non-conductive output 163 from fourth roller 118, produces a stream which is obviously not able to be classed as conductive or non-conductive.

[0051] Illustrated in figure 6 and table 2 is another illustrative hypothetical example using the same mixture of minerals to be separated as in figure 5. Table 2 is a tabular version of the figure 6 information. The machine set up is the same as that for the machine 100 of figure 3, where the third roller 116 and fourth roller 118 each have three output streams, being a conductive outputs 142 and 143 respectively, to the right, a non-conductive outputs 162 and 163 respectively, to the left; and mids or middling outputs 152 and153 respectively. The rollers 112 and 114 also each have three output streams respectively being: conductive outputs 140, 141; mids or middling outputs 150, 151; and non-conductive 160, 161.

[0052] In the example of figure 6, the zircon output is the non-conductive particulate, while the rutile is the conductive particulate. It will be noted that the percentage of rutile in the conductive output 143 of fourth roller 118 is relatively high, as is the non-conductive output 162 of the third roller 116. Whereas the true mids output, being a combination of the streams 151 from second roller 114, and the conductive output 142 from third roller 116 and non-conductive output 163 from fourth roller 118, produces a stream which is obviously not able to be classed as conductive or non-conductive. Further the mids outputs 152 and 153 from the rollers 116 and 118 are sufficiently high in purity to be referred to as second stream non-conductive and conductive outputs respectively. These second streams are sufficiently refined with a high enough percentage of zircon and rutile respectively, so as to pass into a second stage of separation, separate from the other output streams.

[0053] Illustrated in figure 7 and table 3 is further illustrative hypothetical example using a mixture of zircon to rutile in the ratios of 70% to 30%. Table 3 is a tabular version of the figure 7 information. The machine set up is different from that of figures 2 and 3, in that the third roller 116 has two output streams being a conductive output 142 and a non-conductive output 162 while the fourth roller 118 has three output streams, being a conductive outputs 143, non-conductive output 163 and a mids output 153. The rollers 112 and 114 also each have three output streams respectively being: conductive outputs 140, 141; mids or middling outputs 150, 151; and non-conductive 160, 161.

[0054] In the example of figure 7, the zircon output is the non-conductive particulate, while the rutile is the conductive particulate. It will be noted that the percentage of rutile in the conductive output 143 of fourth roller 118 is relatively high, as is the non-conductive output 162 of the third roller 116. Whereas the mids output, being a combination of the streams 151 from second roller 114, and the conductive output 142 from third roller 116 and non-conductive output 163 from fourth roller 118, produces a stream which is obviously not able to be classed as

conductive or non-conductive. Further the mids output 153 from the roller 118 is sufficiently high in purity to be referred to as second stream conductive outputs. This second stream is sufficiently refined with a high enough percentage of rutile, so as to pass into a second stage of separation, separate from the other output streams.

[0055] In the examples the conductive outputs 143 of figures 5, 6 and 7; second stream conductive output 153 of figures 6 and 7; and the non-conductive outputs 162 of figures 5, 6 and 7; and second stream non-conductive outputs 152 of figure 6; and the mids outputs 151 plus 142 plus 163 of figures 5, 6 and 7 are all re-processed through the same machine 100 or a second one of these machines so as to get the refinement of the zircon and the rutile above 99%, whereby the product is then passed through machines 206 and 208 as in figure 4, for even greater refinement.

[0056] Illustrated in figure 8 is a in line arrangement four roller machine 1000, which is similar to the machine 100 described above, and like parts have been like numbered. The machine 1000 differs from the machine 100 in that the fourth roller 118 is positioned so that its non-conductive feed can be re-treated by the third roller 116. Otherwise, the machine 1000 is the same as the machine 100 of figure 3, where each roller has three output streams.

[0057] In the above examples the rollers 112, 114, 116 and 118 all rotate in the clockwise direction, which will mean that the respective ionisation electrodes are positioned on the right hand side of the rollers. This will result in the conductive particulates moving off the roller to the right hand side. It will be readily understood that if an anti-clockwise rotation were required of the rollers, that the electrodes would be required on the left hand side of the rollers, and the conductive particulate would exit to the left.

[0058] It will be understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text. All of these different combinations constitute various alternative aspects of the invention.

[0059] The foregoing describes embodiments of the present invention and modifications, obvious to those skilled in the art can be made thereto, without departing from the scope of the present invention.

Dated this 7th day of April 2004
Roche Mining (MT) Pty Limited
By its patent attorneys
Halford & Co

C04040P

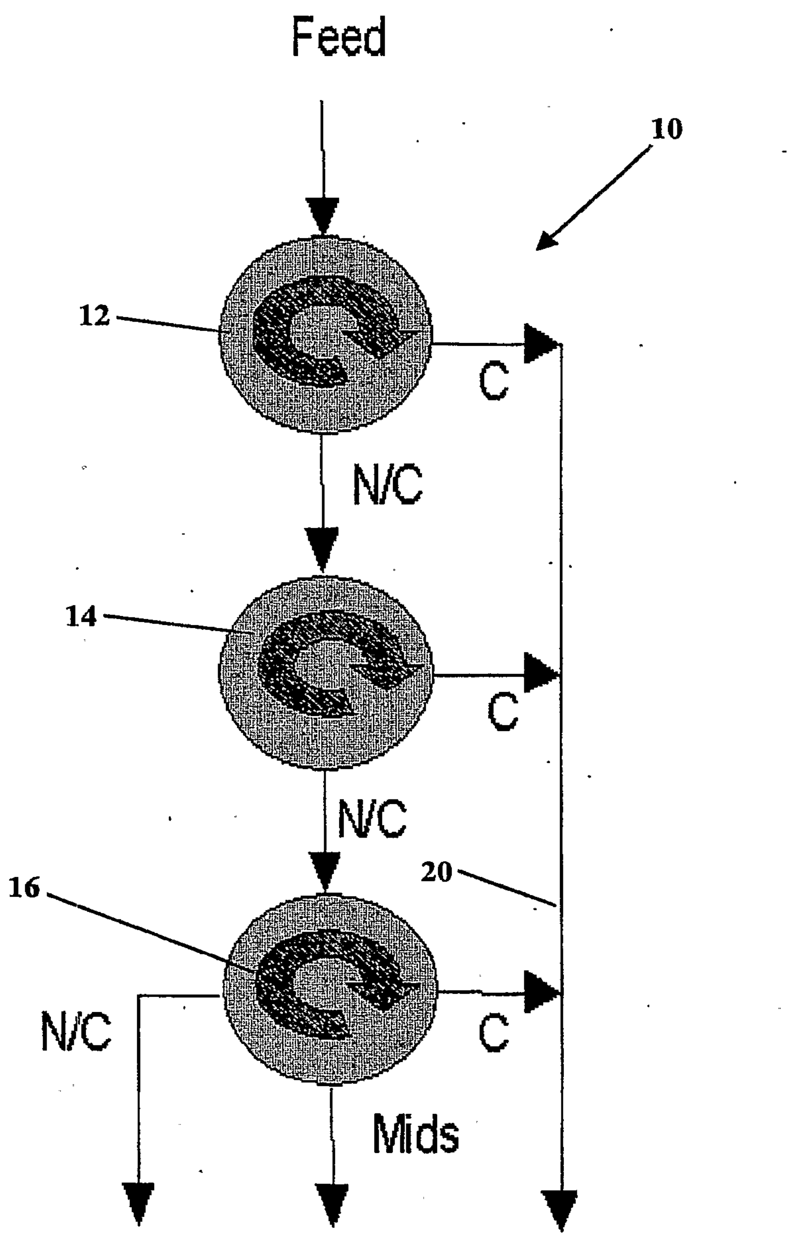


FIG1

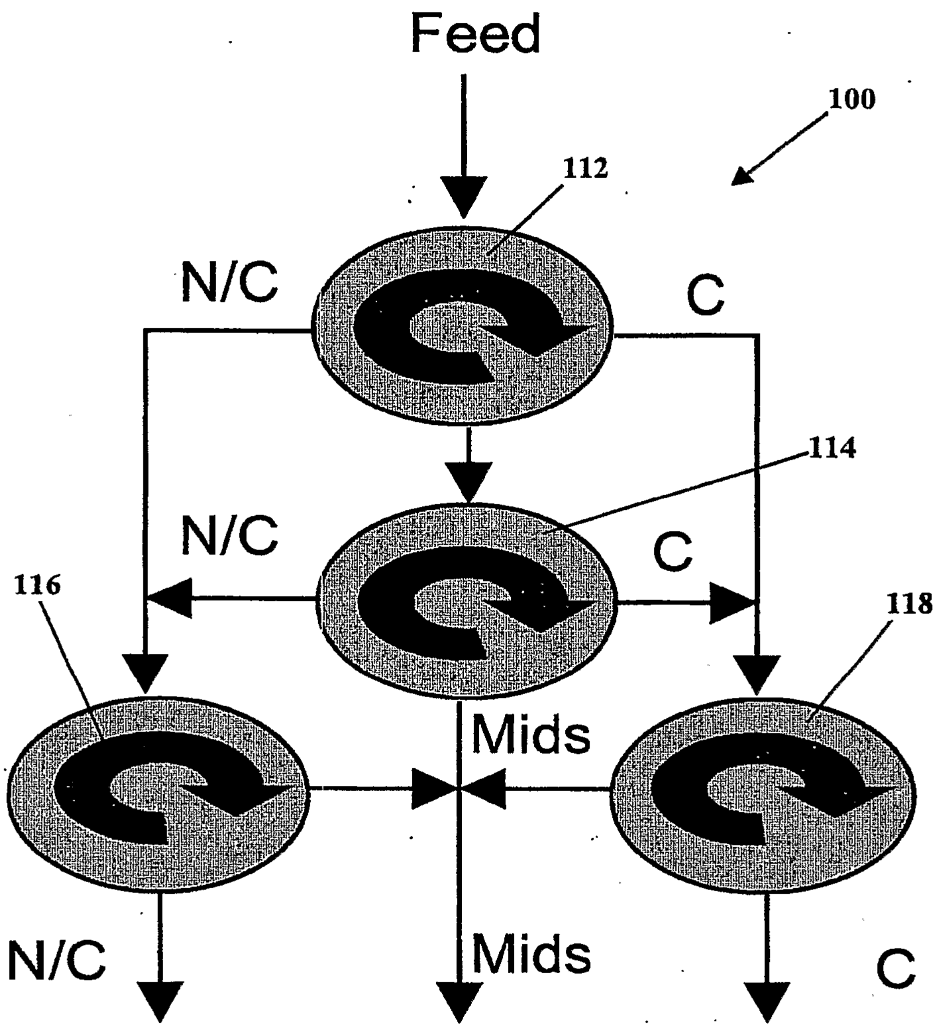
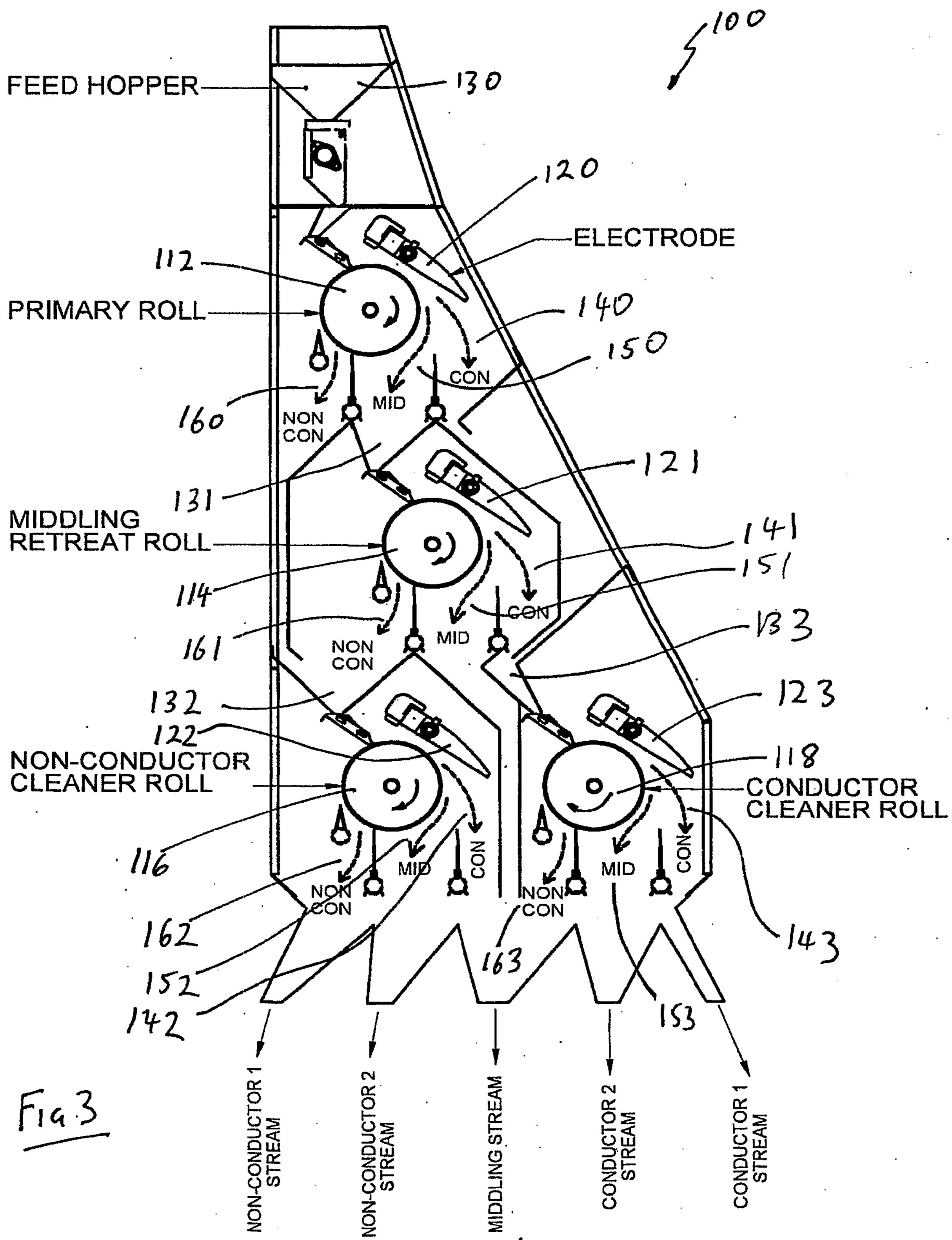


FIG 2


100
FEED HOPPER
130
120
ELECTRODE
112
PRIMARY ROLL
140
150
CON
MID
NON CON
160
121
131
MIDDLING RETREAT ROLL
141
151
114
CON
MID
NON CON
161
133
123
132
122
NON-CONDUCTOR CLEANER ROLL
118
CONDUCTOR CLEANER ROLL
116
MID
CON
NON CON
MID
CON
NON CON
162
152
142
163
143
153
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NON-CONDUCTOR 2 STREAM
MIDDLING STREAM
CONDUCTOR 2 STREAM
CONDUCTOR 1 STREAM

Fig 3

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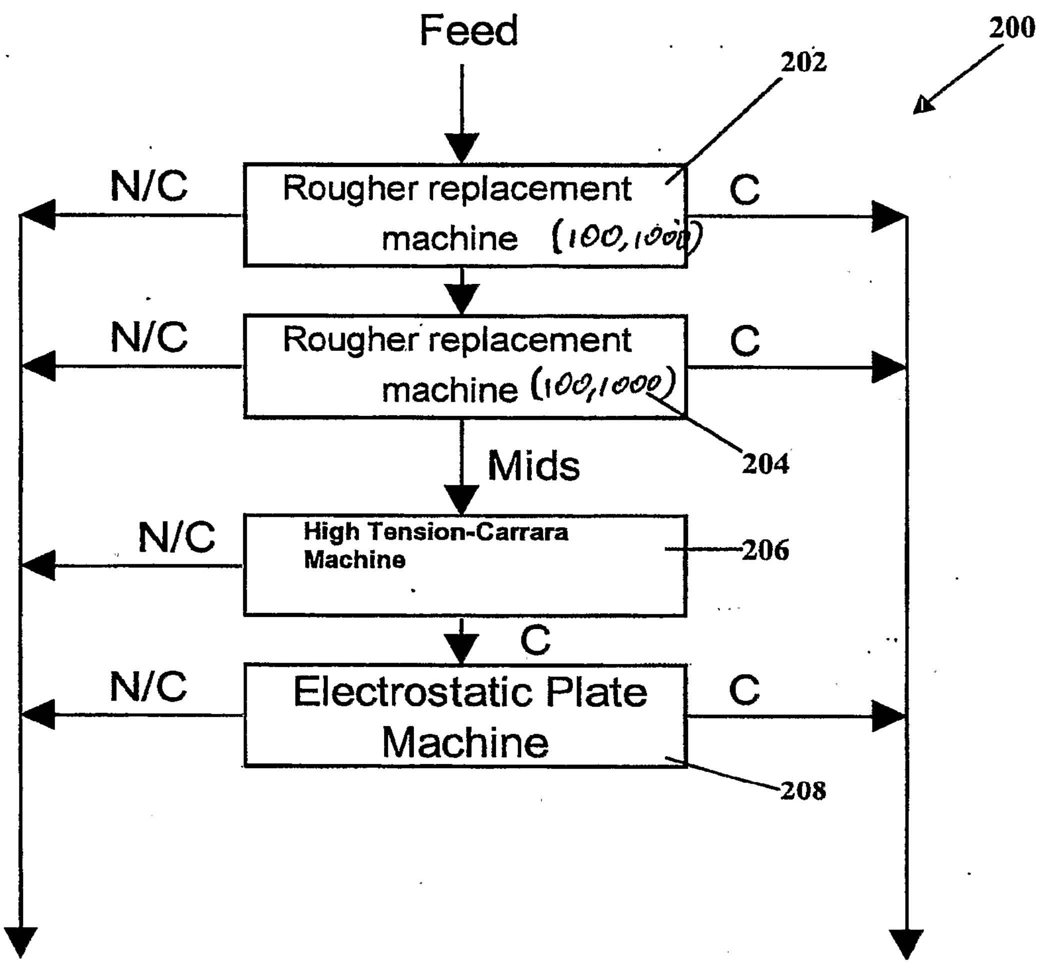

FIG 4

Internal Flowsheet for a single Machine

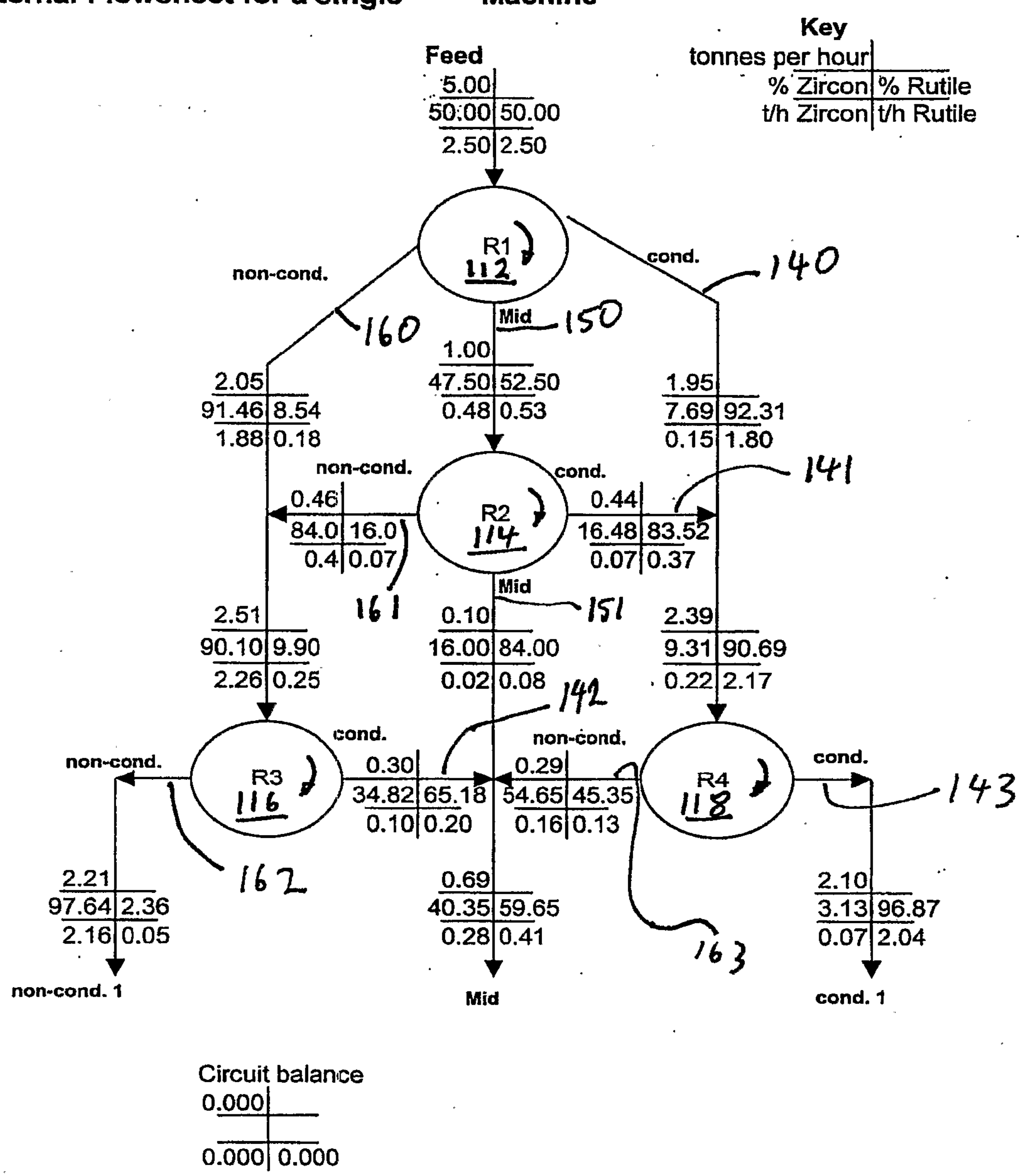

FIG 5

Roll 1

Stream Name	Mass Distribution %	Flow rate t/h	Zircon (n/c) grade %	Zircon (n/c) Distribution %	Rutile (cond.) grade %	Rutile (cond.) Distribution %
conductive	39	1.95	7.7	6.0	92.3	72.0
Mid	20	1.00	47.5	19.0	52.5	21.0
Non-conductive	41	2.05	91.5	75.0	8.5	7.0
Feed	100	5.00	50.0	100.0	50.0	100.0

Roll 2

conductive	44	0.44	16.5	15.3	83.5	70.0
Mid	10	0.10	16.0	3.4	84.0	16.0
Non-conductive	46	0.46	84.0	81.4	16.0	14.0
Feed	100	1.00	47.5	100.0	52.5	100.0

Roll 4

conductive	88	2.10	3.1	29.6	96.9	94.0
Non-conductive	12	0.29	54.7	70.4	45.3	6.0
Feed	100	2.39	9.3	#DIV/0!	90.7	100.0

Roll 3

conductive	12	0.30	34.8	4.6	65.2	79.0
Non-conductive	88	2.21	97.6	95.4	2.4	21.0
Feed	100	2.51	90.1	#DIV/0!	9.9	100.0

Table 1

Internal Flowsheet for a single Machine

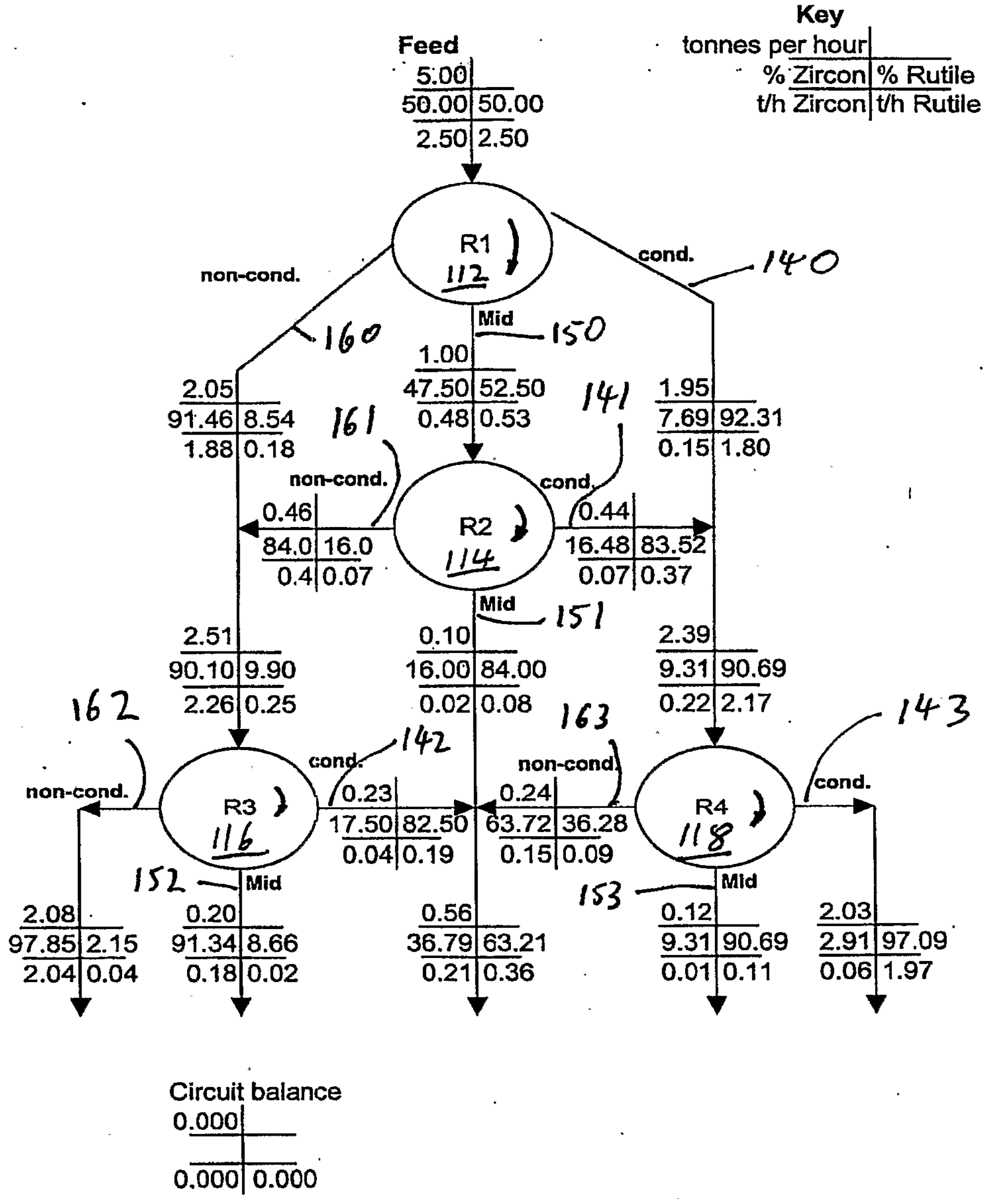

FIG 6

Roll 1						
	Mass	Flow	Zircon (n/c)		Rutile (cond.)	
Stream Name	Distribution %	rate t/h	grade %	Distribution %	grade %	Distribution %
conductive	39	1.95	7.7	6.0	92.3	72.0
Mid	20	1.00	47.5	19.0	52.5	21.0
Non-conductive	41	2.05	91.5	75.0	8.5	7.0
Feed	100	5.00	50.0	100.0	50.0	100.0
Roll 2						
conductive	44	0.44	16.5	15.3	83.5	70.0
Mid	10	0.10	16.0	3.4	84.0	16.0
Non-conductive	46	0.46	84.0	81.4	16.0	14.0
Feed	100	1.00	47.5	100.0	52.5	100.0
Roll 4						
conductive	85	2.03	2.9	26.6	97.1	91.0
Mid	5	0.12	9.3	5.0	90.7	5.0
Non-conductive	10	0.24	63.7	68.4	36.3	4.0
Feed	100	2.39	9.3	100.0	90.7	100.0
Roll 3						
conductive	9	0.23	17.5	1.7	82.5	75.0
Mid	8	0.20	91.3	8.1	8.7	7.0
Non-conductive	83	2.08	97.9	90.1	2.1	18.0
Feed	100	2.51	90.1	100.0	9.9	100.0

Table 2

Internal Flowsheet for a single Machine

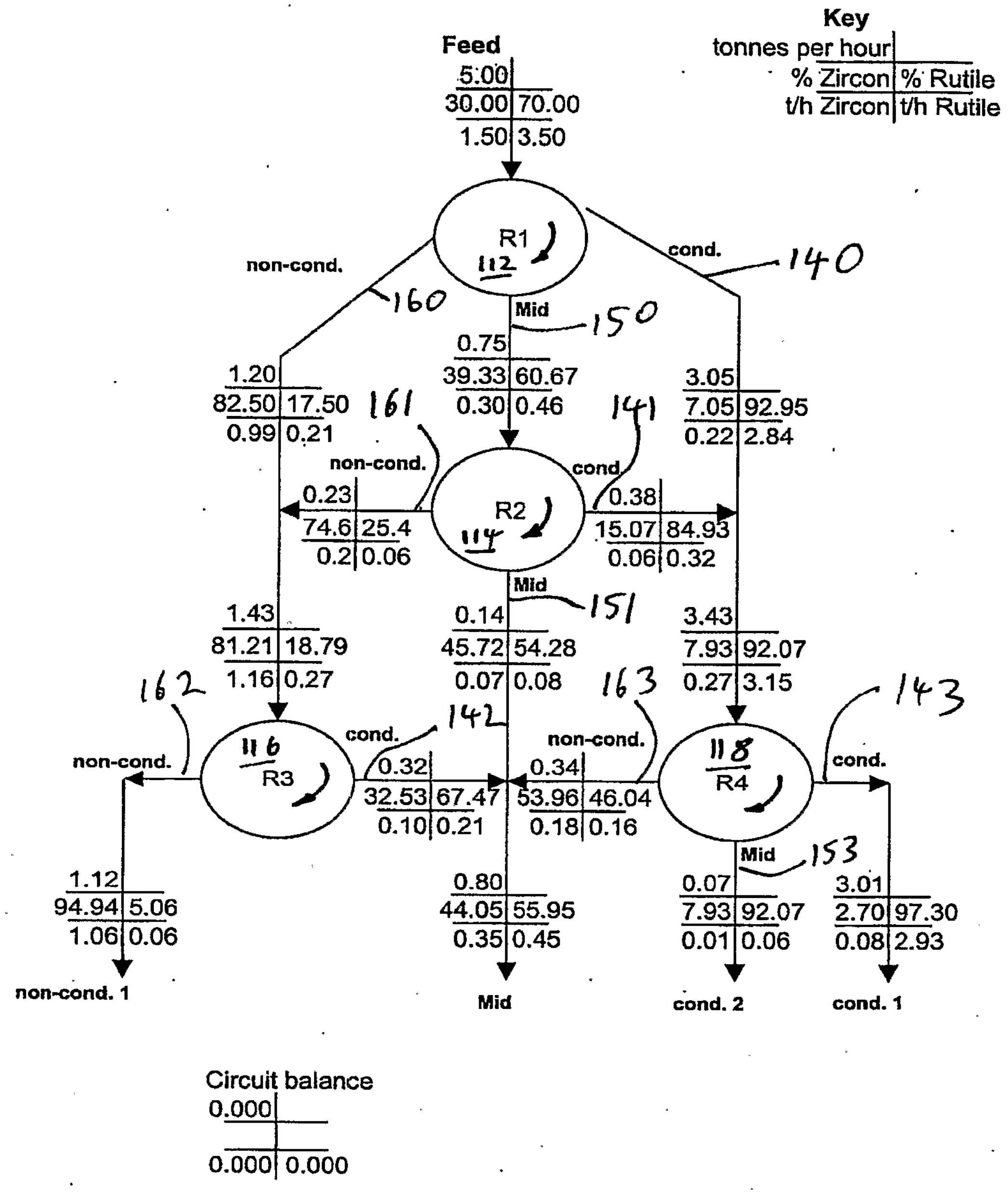

FIG 7

9/11

Roll 1

Stream Name	Mass Distribution %	Flow rate t/h	Zircon (n/c) grade %	Zircon (n/c) Distribution %	Rutile (cond.) grade %	Rutile (cond.) Distribution %
conductive	61	3.05	7.0	14.3	93.0	81.0
Mid	15	0.75	39.3	19.7	60.7	13.0
Non-conductive	24	1.20	82.5	66.0	17.5	6.0
Feed	100	5.00	30.0	100.0	70.0	100.0

Roll 2

conductive	50	0.38	15.1	19.2	84.9	70.0
Mid	19	0.14	45.7	22.1	54.3	17.0
Non-conductive	31	0.23	74.6	58.8	25.4	13.0
Feed	100	0.75	39.3	100.0	60.7	100.0

Roll 4

conductive	88	3.01	2.7	29.9	97.3	93.0
Mid	2	0.07	7.9	2.0	92.1	2.0
Non-conductive	10	0.34	54.0	68.1	46.0	5.0
Feed	100	3.43	7.9	100.0	92.1	100.0

Roll 3

conductive	22	0.32	32.5	8.8	67.5	79.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Non-conductive	78	1.12	94.9	91.2	5.1	21.0
Feed	100	1.43	81.2	#DIV/0!	18.8	100.0

TABLE 3

Alternative Internal Flowsheet for a single Machine

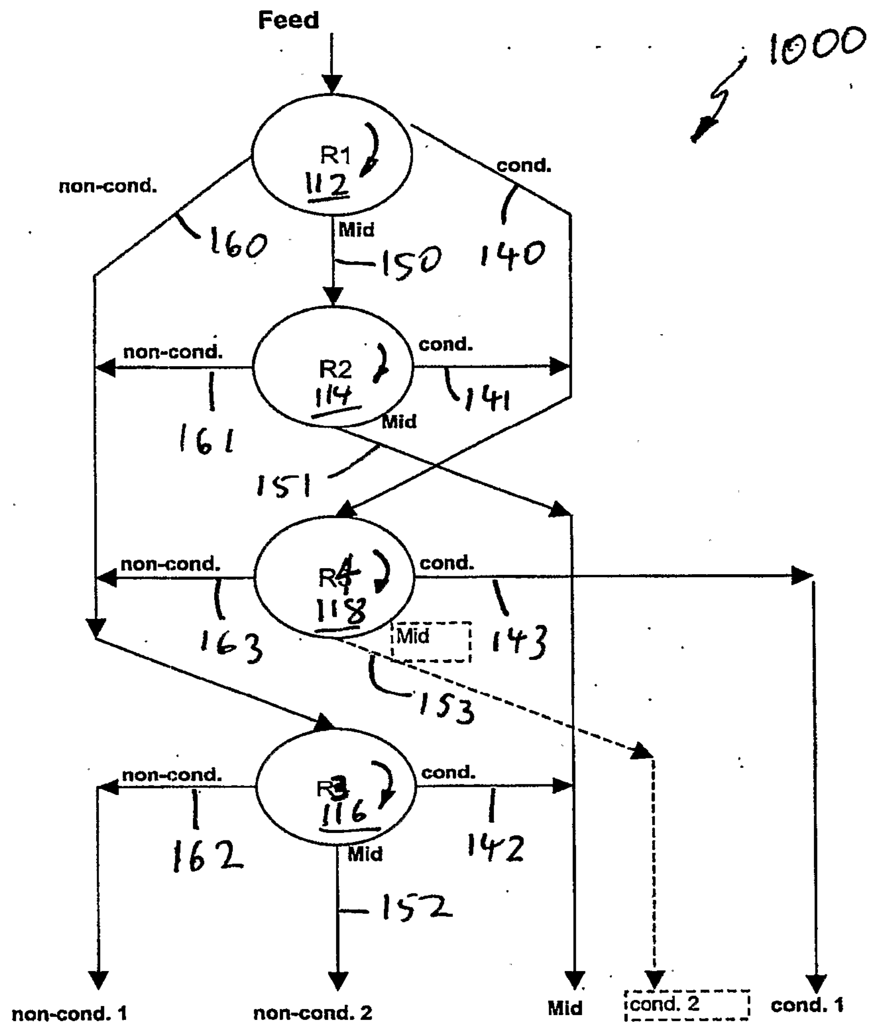

FIG 8